UNIVERSITY OF TORONTO
THE PROVINCIAL UNIVERSITY OF ONTARIO

Course
in
Aeronautical Engineering

DEPARTMENT OF MECHANICAL ENGINEERING
FACULTY OF APPLIED SCIENCE AND ENGINEERING
1929

Copies of this bulletin may be obtained, free, on application to the Department of University Extension, University of Toronto, Toronto 5.

This pamphlet is intended to furnish information concerning the undergraduate course in Aeronautical Engineering recently established by the University of Toronto.

Information concerning the requirements for admission, tuition fees, and other general information will be found in the Calendar of the Faculty of Applied Science and Engineering, a copy of which may be secured by addressing the Secretary of the Faculty.

FOREWORD

The dependence of national development and progress on transportation is nowhere more marked than in Canada. The settlement and development of the country has here followed, first, the natural waterways, then the railways, and now is following the airways. Regions formerly regarded as inaccessible and doomed to remain forever undeveloped are now not only being explored, but are actually in process of development almost entirely by means of aircraft. For the building up of effective national air transportation, trained aeronautical engineers are indispensable, and the training of aeronautical engineers is, therefore, a matter of national importance.

The Aerodynamic Laboratory of the University of Toronto

COURSE IN AERONAUTICAL ENGINEERING

HISTORICAL

The University of Toronto occupies a unique position among the Universities of Canada in offering the only course in Aeronautical Engineering, and in possessing the only Aerodynamic Laboratory in the Dominion equipped for aeronautical instruction, post-graduate research and for testing.

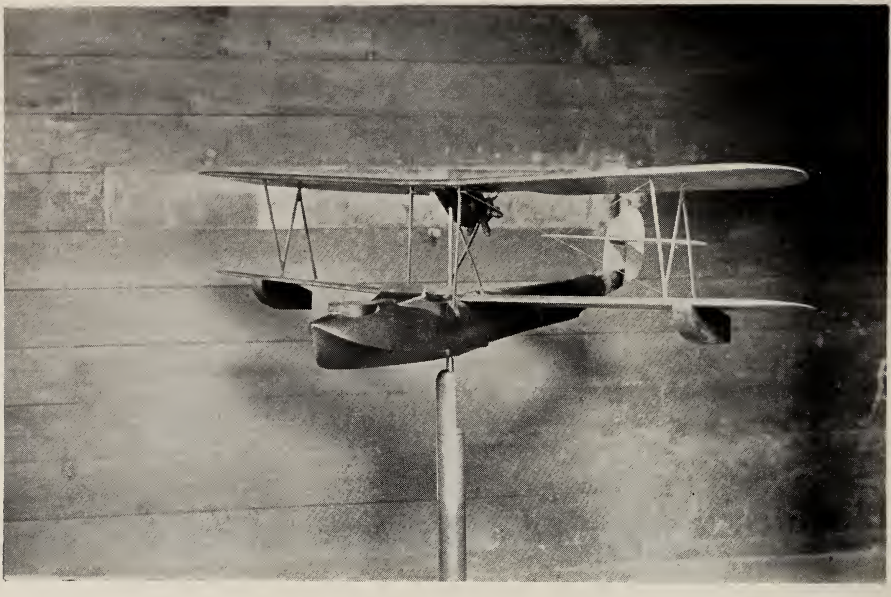
Foreseeing the important part to be played by air transportation in the development of Canada, and appreciating the fact that an aerodynamic laboratory would greatly facilitate aerial development, the Board of Governors established in 1917 an Aerodynamic Laboratory, complete with wind tunnel and equipment.

Since that time researches have been conducted in the laboratory more or less continuously, and the laboratory has taken a not unimportant part in the advancement of aviation in the Dominion and in the development of aircraft suited to Canadian requirements and conditions.

Canada offers an excellent field for the use of aircraft, and in the past few years much sound progress has been made in applying aircraft to the peculiar needs of the Dominion, with the result that aircraft are now used in considerable numbers for such operations as forest patrol, aerial photography and surveying, exploration and transportation in the remoter regions, and air mail, express and passenger services. The supplying of aircraft, often of special character, for these purposes, has resulted in the establishment of aircraft and engine plants, thereby initiating the aircraft industry in the Dominion.

By 1928 the infant aircraft industry was well established and gave such promise of future importance that the University considered that the time had arrived for the establishing of a course in Aeronautical Engineering to satisfy the growing demand for aeronautic instruction, meet the existing need of the industry for aeronautical engineers, and anticipate its future requirements.

The University of Toronto, with the experience gained in more than ten years of aeronautical research and the laboratory equipment developed in that time, and possessing an excellent engineering faculty and laboratories, was in a particularly favourable position to undertake instruction in Aeronautical Engineering.



AERONAUTICAL EDUCATION

The aeronautical engineer applies basic scientific principles to the particular problems arising in the practice of his profession. The underlying principles in aeronautical engineering differ in no way from those in the older, more common, branches of engineering and the applications are, generally speaking, refinements of those in well established engineering practice. In his education as an aeronautical engineer, the student must first be given a thorough understanding of fundamental scientific principles, and must then be trained in the methods of applying this knowledge to aeronautical problems. Fundamentals and methods must be stressed, since the young engineer can rely only on his ability to reason from first principles, coupled with initiative and sound judgment, to enable him to cope successfully with the new situations constantly arising in a science developing as rapidly as that of aeronautics. Information becomes too rapidly obsolete, and experience can be gained only in actual practice.

FIELD FOR AERONAUTICAL ENGINEERS

Aeronautical engineering is one of the newest branches of the engineering profession.

Originally, the aeronautical engineer was concerned principally with the design of aircraft. With the expansion of the industry his work has been extended and now includes supervision of construction, improvement of production, superintendence of operation and maintenance and, through research, the general improvement of the efficiency and safety of aircraft.

As, at the present time, most aircraft are of the heavier-than-air type, the field for aeronautical engineers in lighter-than-air work is much less extensive.

The design and construction of aircraft engines is also an important field of service for aeronautical engineers. The requirements of aircraft engines are such as to call for considerable aeronautical knowledge on the part of designers and constructors, in addition to thorough training in prime movers, particularly of the internal combustion type, fuels and allied subjects.

DEMAND FOR AERONAUTICAL ENGINEERS

While the number of engineers employed in aeronautical work will probably never be as great as in some of the older branches of engineering, there is at the present time, and will be in the future, a definite, though limited, demand for aeronautical engineers. It is estimated that the industry in Canada can absorb from six to ten engineers per year in aircraft and engine construction at the present time, and this number may be expected to increase as the industry expands. Other authoritative estimates have placed the foregoing figures as high as eighteen to thirty.

Because of the small number of openings likely to be available, the University proposes to limit the number taking the course in aeronautical engineering and, in view of the nature of the course, to restrict the registration to those who, besides having a genuine interest in aeronautics, have exhibited in their previous work marked ability and aptitude in mathematics, mechanics, and science.

Care has been taken in planning the course to avoid the danger of over-specialization which would, in the event of the graduate being unable to secure a place in aeronautical work, preclude him from working in other lines of engineering. A graduate of the aeronautical engineering course will be under no handicap in filling positions in the automotive or most other branches of mechanical engineering.

Graduates of the course in aeronautical engineering will find employment in the engineering departments of aircraft and engine manufacturing plants, with aircraft operating companies, in connection with the construction and operation of airports and airways, and a limited number in research and instruction. Young graduate aeronautical engineers of ability entering the industry in the near future should, as the industry expands, be in a position to rise to important and responsible positions.

It cannot be too strongly emphasized that the demand of the aeronautical industry will be for quality rather than quantity in its technical personnel.

Wind Tunnel in the Aerodynamic Laboratory of the University of Toronto. The only Wind Tunnel in Canada.

UNDERGRADUATE CURRICULUM

The undergraduate course in Aeronautical Engineering has been arranged as an option in the third and fourth years of the regular course in Mechanical Engineering. In the latter course, in the Junior years, the student is given a thorough grounding in the subjects of mathematics, mechanics, physics and chemistry, together with instruction in certain general subjects, such as English, business and economics, and some practice in engineering drawing and surveying. Specialization commences in the third year with a very limited amount of instruction in aeronautical subjects. In the fourth year a large part of the time is devoted to aeronautical work. The course is planned to give the student thorough training in fundamental engineering principles with sufficient specialized aeronautical instruction to render him somewhat conversant with aeronautic science and methods.

First Year—During the first and second years, the student planning to enter the aeronautical course takes the regular course in Mechanical Engineering. The first year, in the latter course, is largely devoted to mathematics, mechanics, chemistry, and electricity. Instruction and practice in mechanical drawing and surveying are also given. The remaining time is occupied by such subjects as English, business, and physical training.

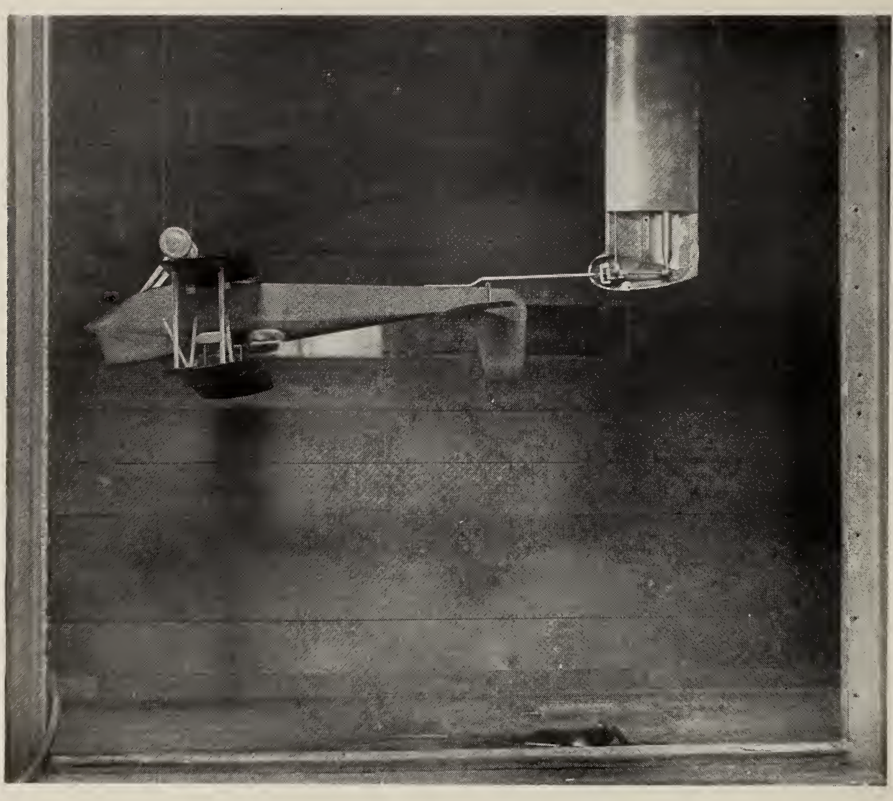
Second Year—In the second year of the course in Mechanical Engineering, the work in mathematics, mechanics, chemistry and electricity is continued. Courses in mechanism, metallurgy, steam engines, mechanical technology and economics and finance are introduced. Problems and examples, where possible, are worked out in the drafting room.

Third Year—In the third year, the course in the aeronautical option is much the same as in the mechanical engineering course. The work includes lecture and laboratory courses in thermodynamics, hydraulics, machine design, electricity and structures, with lecture courses in chemistry and metallurgy. The aeronautical work comprises lecture courses in Elements of Aviation and Elementary Aerodynamics and a course in Advanced Calculus. The time for the latter courses is obtained by eliminating some of the work of the mechanical engineering course dealing with steam boilers and reducing slightly the drafting room time in machine design.

Fourth Year—The fourth year of the aeronautical option differs considerably from that of the course in Mechanical Engineering, although the courses in management, economics, and metallurgy are the same. The work on concrete is eliminated. Hydraulics is replaced by aerodynamics; aircraft design takes the place of machine design; and a course in aircraft structure replaces that dealing with ordinary engineering structures. Some work in thermodynamics dealing with steam and refrigeration is omitted, and a course in aircraft engines is added. The mathematical work is continued with a course on differential equations. Courses on aircraft materials and propellers are introduced.

Thesis—As in the other engineering courses, a thesis is required in the fourth year to complete the requirements for the degree of Bachelor of Applied Science. As far as possible, students in the aeronautical option are encouraged to select, as subjects for the thesis, problems capable of investigation experimentally in the aerodynamic laboratory.

It will be evident from the foregoing outline that the aeronautical work has been introduced into the regular mechanical course without sacrificing the fundamental subjects; in fact, the work in mathematics has been considerably increased. The result is a well balanced and comprehensive course, covering the fundamentals of mechanical engineering and affording reasonable specialization in aeronautical subjects. The complete curriculum is shown in tabular form and detailed prescriptions of the aeronautical courses of instruction are given later.



Model in Wind Channel (showing "wobbler").

SHOP WORK

In the regular course in Mechanical Engineering, a student is required, before graduation, to have worked not fewer than 1,600 hours in the mechanical trades, in manufacture, or on construction. The time should be spent, preferably, in pattern shop, foundry, forge, and machine shops. The object of this requirement is twofold; first, that the student may obtain experience in shop methods and processes under commercial conditions and, second, that he may be brought into contact with the workmen, with benefit to both.

The shop work is usually done during the three vacations of the course.

Students taking the Aeronautical Option must satisfy this requirement. The shop work for the aeronautical students should preferably be done in aircraft or engine plants, or in maintenance work with an aircraft operating company.

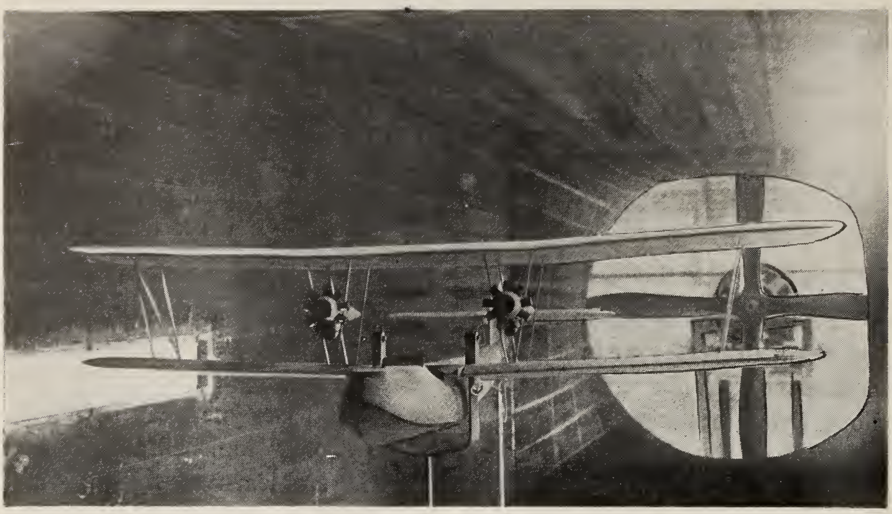
Flying—Instruction in flying is not given officially at the University, and is not necessary in order to proceed with the course in aeronautical engineering. While there are many excellent designers who are not pilots, flying training is an asset to an aircraft designer. Aeronautcal engineers in the future will find the ability to fly indispensable in the practice of their profession. Those desiring to learn to fly will find ample opportunities either through flying clubs or in private flying schools.

COURSE OFFERED BY THE ROYAL CANADIAN AIR FORCE

The Royal Canadian Air Force offers a course of training for University students at Camp Borden. A limited number of students in science holding the Practical Certificate A in the Canadian Officers' Training Corps is selected from each University. The course extends over about twelve weeks during each of the three vacations of the University course. Instruction is given in theory of flight, wood and metal shop work, aircraft engines, aircraft rigging, practical flying, (about 70 hours dual and solo), air pilotage and map reading and meteorology, as well as other purely military subjects. During the course, candidates are given the rank of Provisional Pilot Officer in the Non-Permanent R.C.A.F., and on successfully completing the course are granted their wings.

By agreement with the Royal Canadian Air Force, the University accepts the work of this course in lieu of shop work, but the course is otherwise not in any way connected with the University. The selection of candidates for the course rests solely with the Royal Canadian Air Force. Students desiring to qualify for the course should enroll in the C.O.T.C. at the beginning of their first year at the University.

Students taking the course in Aeronautical Engineering who are able to take the Camp Borden course are, on graduation, in a position to enter the industry under very favourable conditions.



Model of twin-engined flying boat arranged for wind tunnel test.

LABORATORIES

The experimental work in aerodynamics is carried on in the aerodynamic laboratory, which forms a wing of the Mechanical Building.

The aerodynamic laboratory is equipped with a four-foot Royal Aircraft Establishment type wind channel, in which air speeds up to 60 miles per hour can be attained. A cellular wall across the laboratory and a honeycomb in the intake of the tunnel secure an air stream at the working section of great smoothness and steadiness. The air is circulated by means of a four bladed propeller 9′ 6″ in diameter, directly connected to a 20 H.P. electric motor.

An aerodynamic balance of the National Physical Laboratory type is set up below the tunnel and is employed for aerofoil and other tests, where a spindle support is convenient. A pair of wire suspension balances are mounted above the tunnel and are used for many tests, particularly those of complete models of aircraft.

Micromanometers of different types, anemometers, accurate alignment devices, and other instruments required for aerodynamic testing and research, are available, as well as aerofoil and other models.

Experimental work in the other subjects of the course is given in the extensive and well equipped laboratories of the Faculty of Applied Science and Engineering, including thermodynamic, hydraulic, electrical, strength of materials, and others.

POST-GRADUATE WORK IN AERONAUTICS

Opportunity for graduate study and research in aeronautics leading to the degree of Master of Applied Science, is offered to properly qualified students.

Particulars respecting the requirements for post-graduate degrees will be found in the Calendar of the Faculty of Applied Science and Engineering, or may be obtained by addressing the Secretary of the School of Graduate Studies.

In view of the limited time available for specialization in aeronautical subjects during the undergraduate course in Aeronautical Engineering, the value of post-graduate study in aeronautics can scarcely be over-estimated.

UNDERGRADUATE COURSE IN AERONAUTICAL ENGINEERING

First Year

Subject	No.	Hours per week			
		First Term		Second Term	
		Lect.	Lab'y	Lect.	Lab'y
Calculus	236	2	0	2	0
Analytical Geometry	238	1	0	2	0
Descriptive Geometry	160	1	0	1	0
Surveying	270, 271	1	6	1	0
Statics	1	2	0	2	0
Dynamics	2	2	0	2	0
General Chemistry	85	2	0	1	0
Electricity	135	2	0	2	0
Illuminating Engineering	185 (a)	1	2	1	2
Technical English	122 (a)	1	0	1	0
Business	121	0	0	1	0
Engineering Drawing	166	0	11	0	18
Physical Training	280	0	2	0	2

Second Year

Calculus	237	1	1	1	1
Descriptive Geometry	162	1	0	1	0
Dynamics	3 (a)	1	0	1	0
Mechanics of Materials	4, 9	2	0	2	3
Engineering Chemistry	93	1	0	0	0
Inorganic Chemistry	87A	1	0	0	0
Organic Chemistry	95	0	0	1	0
Metallurgy	241	0	0	1	0
Hydrostatics	186	0	0	1	0
Elementary Machine Design	232	1	0	1	0
Electricity	136, 137	2	3	2	3
Steam Engines	216	1	0	1	0
Theory of Mechanism	230	2	1½	2	1½
Compound Stress	10a	1	0	0	0
Economics and Finance	123	1	0	1	0
Chemical Laboratory	89	0	0	0	6
Engineering Drawing	170	0	15	0	7½
Physical Training	280	0	2	0	2

Third Year

Engineering Chemistry	102	1	0	1	0
Physical Metallurgy	244	0	0	2	0
Theory of Structures	7, 177	2	9	0	0
Thermodynamics	217, 219	2	3	2	3
Heat Engines	218	2	0	0	0
Hydraulics	205, 206	2	0	2	3
Mechanics of Machinery	231	1	0	1	0
Machine Design	233	2	3	2	9
Magnetism & Electricity	138, 140	1	3	1	4½
Alternating Current	139	1	0	1	0
Advanced Calculus	237 (a)	2	1	2	1
Elements of Aviation	301	1	0	1	0
Aerodynamics I	302	0	0	2	0

Fourth Year

Thesis	285	0	1	0	1
Engineering Economics	125	0	0	1	0
Industrial Management	130	1	0	1	0
Heat Treatment of Iron, Steel	253	1	0	1	0
Thermodynamics	220, 222	2	6	2	6
Aircraft Structures	22	2	0	2	0
Differential Equations		2	1	2	1
Aerodynamics II	303	1	0	1	0
Aerodynamic Laboratory	304	0	6	0	6
Aircraft Materials	305	1	0	0	0
Aeroplane Design and Stress Analysis	306	2	8	2	8
Aircraft Propellers	307	1	0	1	0
Aircraft Engines	308	1	0	1	0

22. Aircraft Structures.—C. F. Morrison.
Dept. 3 (a) IV Year; 2 hrs. per week; both terms.
Determination of the stresses in the different members of aircraft structures. The method of least work and the generalized theorem of three moments.
Reference Books:—Aeroplane Structures—Pippard and Pritchard.
Airplane Structures—Niles.

301. Elements of Aviation.—J. H. Parkin.
Dept. 3 (a) III Year; 1 hour per week, both terms.
An introductory course of lectures covering classes of aircraft, types of aeroplanes, elementary construction of aeroplanes, principles of flight (including elementary consideration of performance and longitudinal balance). Aerofoil action, characteristics and coefficients.

302. Aerodynamics I.—J. H. Parkin.
Dept. 3 (a) III Year; 2 hours per week, second term.
A lecture course dealing with standards and units, properties of air, standard atmosphere, coefficients, theory of model testing and dynamical similarity, scale effect, methods and apparatus of test, aerodynamic properties of aerofoils and aerofoil combinations, parasite drag.

303. Aerodynamics II.—J. H. Parkin.
Dept. 3 (a) IV Year; 1 hour per week, both terms.
A continuation of course 302 dealing with aerofoil theory, aeroplane stability and control, aeroplane performance analysis and calculation, special types of aircraft.

304. Aerodynamic Laboratory.—J. H. Parkin.
Department 3 (a) IV Year; 6 hours per week, both terms.
Calibration and use of instruments, experimental determination of the air forces and moments on model wings, aircraft components and complete aircraft. Pressure plotting, air flow studies.

305. Aircraft Materials.—J. H. Parkin.
Department 3 (a), IV Year; 1 hour per week, first term.
Properties of timber, plywood, fabric, dopes, glue, rubber, light alloys, special steels and of spars and struts of special form, welded connections, tubes, cables.

306. Aeroplane Design and Stress Analysis.—J. H. Parkin.
Department 3 (a), IV Year; 2 hours per week, 6 hours per week in drafting room, both terms.
Load factors, design for aerodynamic and structural requirements. Stresses during different manoeuvres, form, arangement and design of details.

307. Aircraft Propellers.—J. H. Parkin.
Department 3 (a), IV Year; 1 hour per week, both terms.
The theory, design and construction of aircraft propellers and windmills.

308. Aircraft Engines.—E. A. Allcut.
Department 3 (a), IV Year; 1 hour per week, both terms.
A study of the special features of aircraft motors, examination of the different types, special auxiliaries and accessories.